Space Weather Technical Forecast

Issued on Monday 4 November 2024 at 00:57 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate to High solar activity with M-flares expected, and a slight chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was moderate with four weak M-flares over the past 24hrs, the largest of which was a M1.4 at 03/1524 UTC from AR3883 in the southeast disc. There are thirteen active sunspot regions on the visible disc, with three new unnumbered regions. Spots AR3869-AR3875 are now approaching the western limb and as such are becoming difficult to analyse, historically AR3869 was the most complex, with opposite polarity to what would be expected for a southern disc sunspot ("anti-Hale"). AR3878 has now rotated into the western hemisphere. This region contains two delta spots, but has seen these both weaken significantly. AR3881 is now approaching the centre disc and appears to have developed a small delta spot within its intermediate spots. Several new sunspots are emerging over the eastern limb, leading these and currently most complex is AR3883 which appears to contain two delta spots and has produced numerous flares in recent hours. The remainder of the new spots coming over the eastern limb appear to have some significant magnetic looping in SDO 171 imagery, but will have to rotate further onto the disc for a proper analysis to be undertaken. The other spots on the disc have remained fairly stable, or are showing signs of decline.

No Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE/DSCOVR were generally at slightly elevated levels, between around 420-480km/s. Density was initially below average, but became above average from around 03/1700UTC, peaking at 21ppcc at 03/1911UTC. The Interplanetary Magnetic Field (IMF), Bt, was moderate, on a gradually declining trend from around 12nT to 7nT. The north-south component, Bz, was moderately positive (northward directed) until 03/1745UTC, from at which point it became weakly negative (southward directed). Phi angle was variable but favoured a negative direction (towards the Sun) until around 03/1941UTC, at which point it became persistently positive (away from the Sun). Geomagnetic activity was mainly Quiet to Unsettled (Kp0-3), but became active (Kp4) between 04/2100-2400

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was elevated but remained below S1 Minor Radiation Storm level throughout, showing a gradual decline. High energy electron flux (greater than 2MeV) observed by GOES16 was at Background. The associated

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24-hour fluence was well below the Active threshold, with 1.22e6 integrated flux observed at 04/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate or High activity is expected to continue, with occasional M-class flares expected and a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: A CME which left the sun during the 31st Nov has the potential to give a glancing blow to Earth early day 1 (04 Nov). Coronal holes CH86/87 may also cause some enhancement through Day1-2 (04-05 Nov). Generally Unsettled geomagnetic activity is expected initially, with a chance of Active and a slight chance of G1/Minor Geomagnetic Storm intervals given the combined risk of a glancing CME blow and HSS influence. Activity then expected to decline to quiet to unsettled levels by Day 3 (06 Nov) although confidence in this is lower than usual.

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 is now below the S1 Moderate Radiation Storm level, and continuing to slowly decline. However, any further notable flares bring a persistent chance for further enhancement during the period. The high energy electron flux is expected to be Background to Moderate, with the associated fluence forecast to persist below Active levels.

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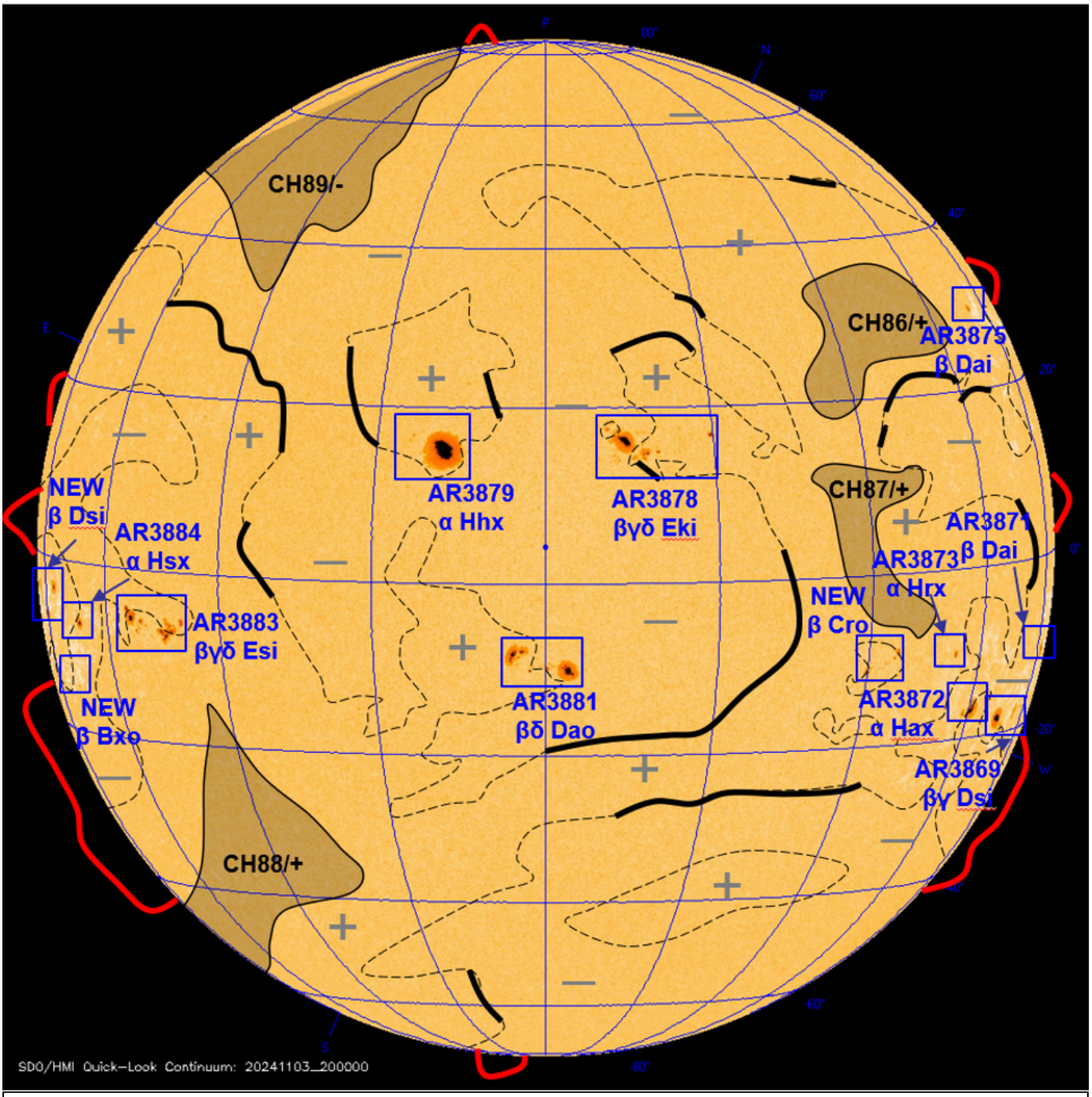
Figure 1: Solar Synoptic Map valid 03/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME which left the Sun during the 31st Oct has the potential to give a glancing blow to Earth early day 1 (04 Nov). This is low confidence however given a lack of imagery for analysis at the time.

The near Earth environment continues to be weakly enhanced with winds currently at slightly elevated levels. Coronal hole CH86/+, or more likely CH87/+ to its south, may cause further enhancement of the solar winds, perhaps to elevated levels through day 1 (04 Nov), sooner than the current MOSWOC ENLIL model indicates. This discrepancy may be due to the coronal holes now being larger and more prominent than on the previous rotation.

Generally Unsettled geomagnetic activity is expected initially, with a chance of Active and a slight chance of G1/Minor Geomagnetic Storm intervals given the combined risk of a glancing CME blow and HSS influence. Activity then expected to decline to quiet to unsettled levels by Day 3 (06 Nov) although confidence in this is lower than usual.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
31/1915	Partial	AR3877	central-southern disk	600	04/0300 +-6hr	Low confidence, glancing blow.

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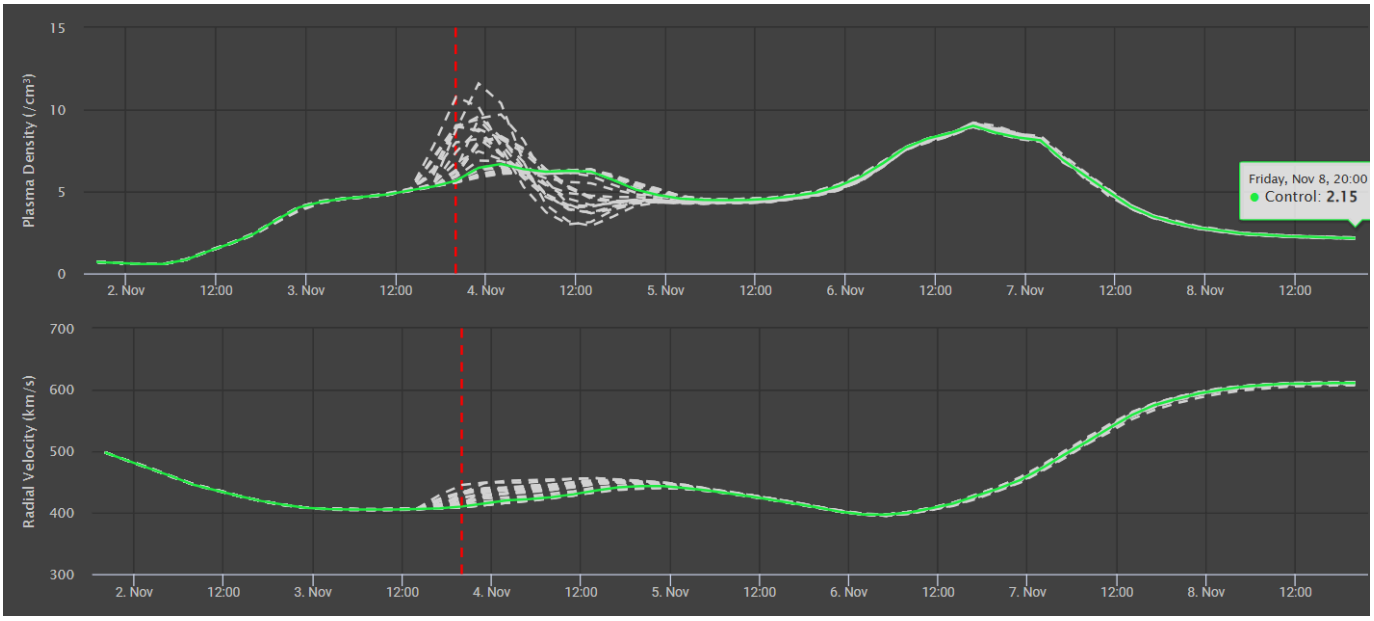
Figure 2: MOSWOC Ensemble model showing possible CME glance. Note that coronal hole influence towards end of the period is likely too late.



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Radio Blackouts - X-Ray Flares

There are thirteen active sunspot regions on the visible disc, with three new unnumbered regions. Spots AR3869-AR3875 are now approaching the western limb and as such are becoming difficult to analyse, historically AR3869 was the most complex, with opposite polarity to what would be expected for a southern disc sunspot ("anti-Hale"). AR3878 has now rotated into the western hemisphere. This region contains two delta spots, but has seen these both weaken significantly. AR3881 is now approaching the centre disc and appears to have developed a small delta spot within its intermediate spots. Several new sunspots are emerging over the eastern limb, leading these and currently most complex is AR3883 which appears to contain two delta spots and has produced numerous flares in recent hours. The remainder of the new spots coming over the eastern limb appear to have some significant magnetic looping in SDO 171 imagery, but will have to rotate further onto the disc for a proper analysis to be undertaken. The other spots on the disc have remained fairly stable, or are showing signs of decline.

Moderate or High activity is expected to continue initially, with occasional M-class flares expected and a slight chance of isolated X-class flares. By day 2 (05 Nov) regions leaving the western limb may slightly reduce overall flare risk, although regions currently rotating over the eastern limb could offset this decrease. As a result, the current flare risk has been maintained, though this forecast may be updated following further analysis of the new regions near the eastern limb.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	80	80	80	80
Very Active	**R3-R5 (X Class)**	No	20	20	20	20

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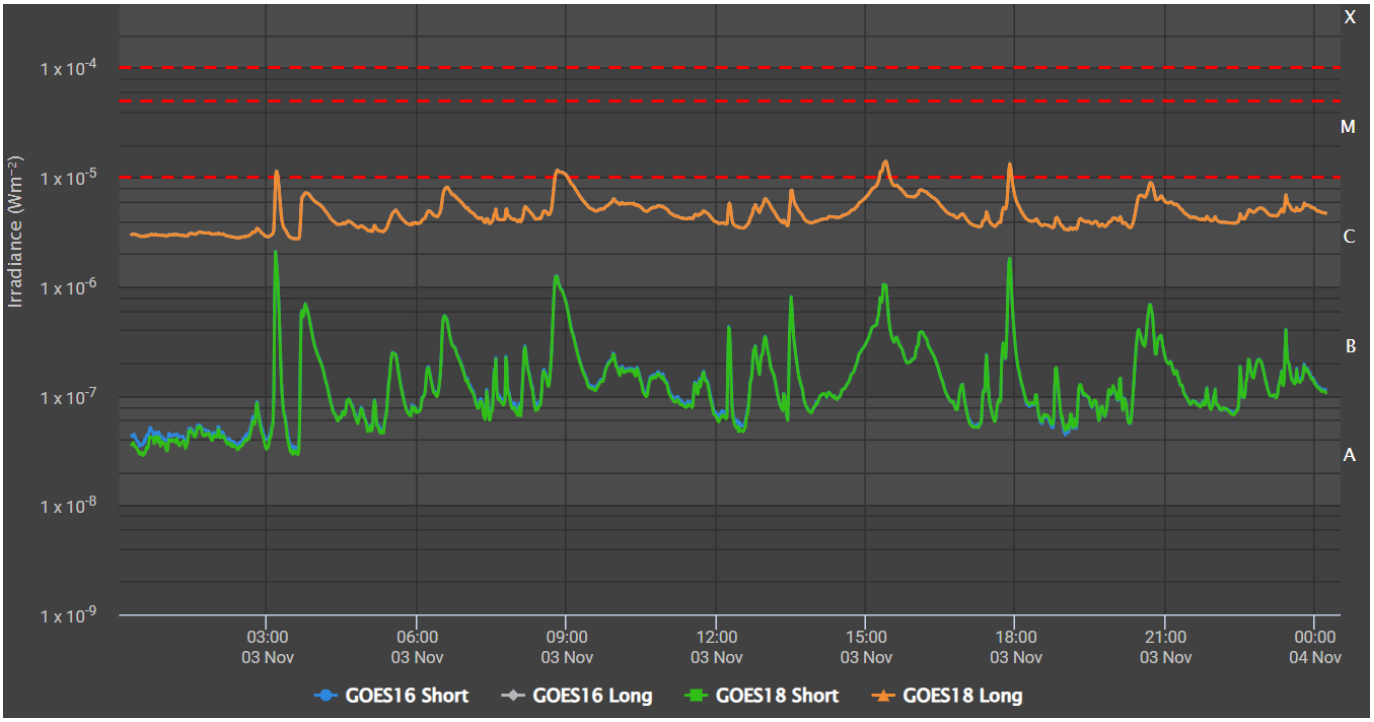
Figure 3: GOES-16 & -18 X-ray flux over past 24hrs



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Solar Radiation Storms (High Energy Protons)

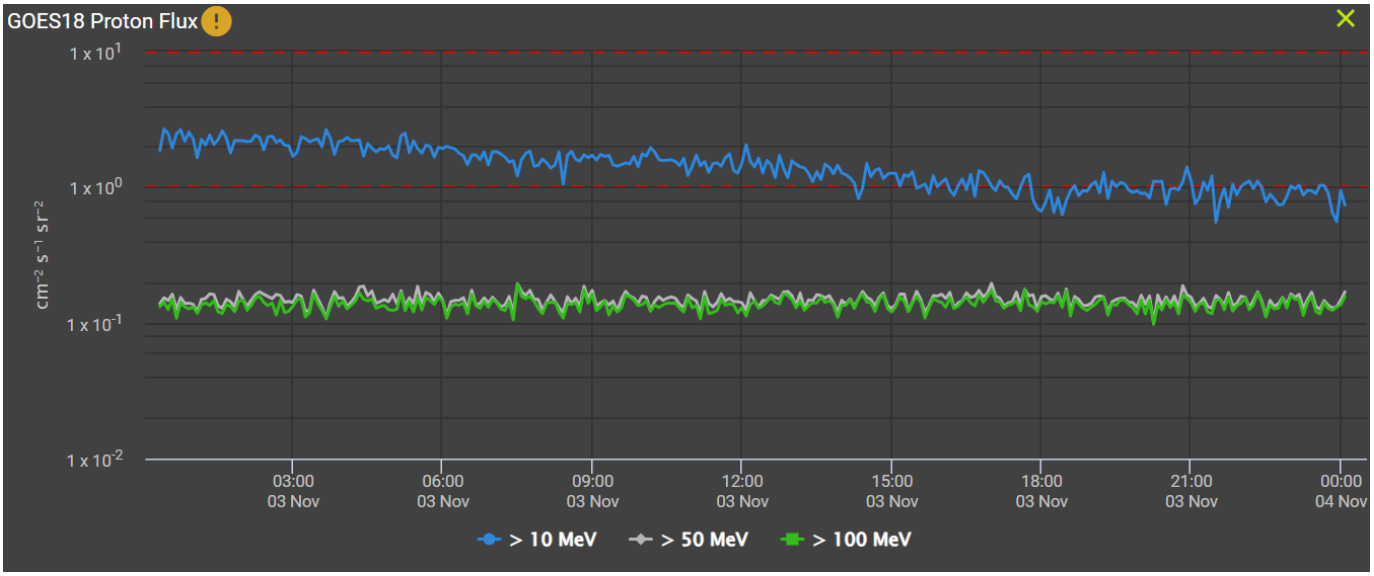
The recently elevated high energy proton flux at GOES-18 over previous days has now fallen below the S1 Minor Radiation storm level and is expected to decline towards background through day 1 (04 Nov) in the absence of any further enhancement.

Further enhancements remain possible however, with the potential for notable flares from a number of the sunspots on the disc. This includes the cluster of regions in the western disc, all of which will remain in potentially geo-effective positions through the period even as some spots round the western limb. The proton risk associated with AR3878 will also only increase into the period as this region transits west, although only limited proton response has been diagnosed from the recent significant flares from this region.

Overall there is a persistent chance of further proton enhancement though the period, reducing slightly through the latter half as conditions likely continue to ease in the absence of further enhancement.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	25	25	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-18 Proton flux over past 24hrs



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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background and expected to persist mostly at this level, with only brief spells of moderate enhancement expected.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with the MOSWOC REFM forecast though to be providing reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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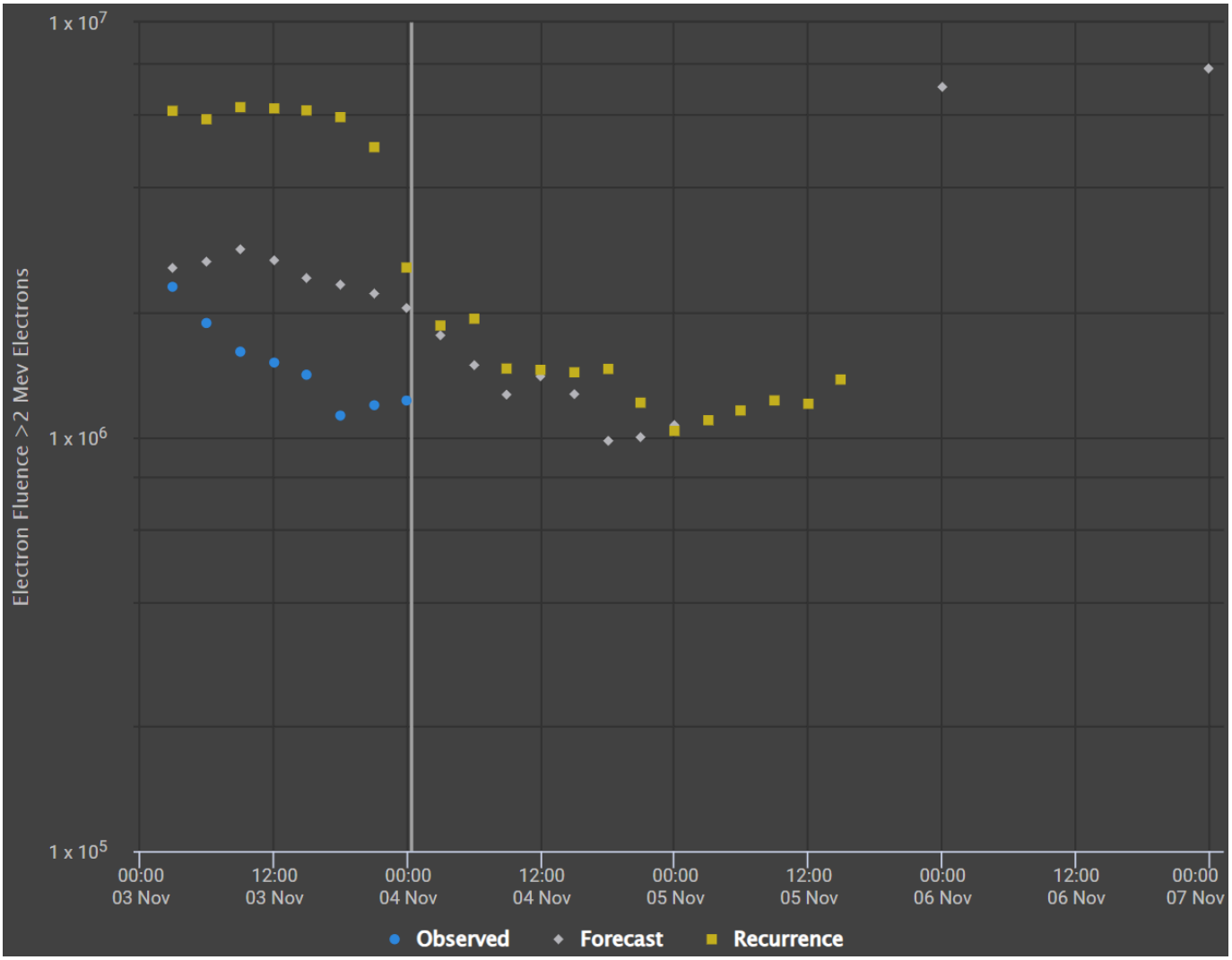
Figure 5: MOSWOC REFM



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